

# THE ROLE OF THE QUADRICEPS MUSCLE IN KNEE EXTENSION†

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## SUMMARY

*In 1949, Smillie proposed that the vastus medialis muscle alone is responsible for the final 10° to 15° of knee extension. A number of more recent studies have proved that the whole quadriceps muscle is responsible for all degrees of knee extension. This evidence is reviewed and the function of the two subdivisions of the vastus medialis is discussed.*

## OPSOMMING

*In 1949 het Smillie voorgestel dat m. vastus medialis alleen verantwoordelik is vir die finale 10° tot 15° van knie ekstensie. 'n Aantal latere studies het bewys dat die hele m. quadriceps verantwoordelik is vir die geheel van knie ekstensie. Hierdie bewyse word bespreek en die funksie van die twee subdivisies van m. vastus medialis word bespreek.*

## WHAT IS THE ROLE OF THE VASTUS MEDIALIS MUSCLE IN KNEE EXTENSION?

Many physiotherapists have probably been taught that the vastus medialis alone is responsible for the final 10° to 15° of knee extension (Gardiner, 1976; Lantzounis, 1931; Smillie, 1949; Smillie, 1970; Wayne Kressley, 1963; Yocum *et al.*, 1978). However, this opinion has been challenged by other authors (Basmajian, 1974; Brewerton, 1955; Hallen and Lindahl, 1962; Lieb and Perry, 1968; Lieb and Perry, 1971; Santavirta, 1971; Wild *et al.*, 1982). The aim of this article is to review the evidence upon which these two opposing opinions are based.

The view that the vastus medialis acts selectively during the last 10° to 15° of knee extension is based on two lines of evidence.

*First*, the British orthopaedic surgeon, Smillie (1949 and 1970) proposed that there are two muscle groups that are active during different phases of knee extension. The first comprises the vastus intermedius, vastus lateralis and rectus femoris muscles which, under normal circumstances, extend the knee to within 10° to 15° of full knee extension. The second component is the selective action of vastus medialis which extends the knee through the last 15°. Smillie came to this conclusion purely on the basis of palpation and visual observation of the quadriceps muscle group contracting through the full range of knee extension.

*Second* is the common observation that, following a period of lower limb immobilization, not only is knee extension impaired, but there appears to be selective atrophy of the vastus medialis, which precedes atrophy of the other knee extensor muscles (Lieb and Perry, 1971). It is an understandable deduction that these two observations are causally related and that the atrophy of vastus medialis is the principal reason for impaired knee extension after lower limb immobilization.

Against this interpretation stands the following evidence:

*First*, when contraction of the vastus medialis is inhibited (as seen visually and proven by electromyography) by infiltration with local anaesthetic, the full force and range of active knee extension is unimpaired (Lieb and Perry, 1971), indicating that the other quadriceps muscles can fulfil both these functions.

*Second*, Santavirta (1979) found that three months after routine meniscectomy, the extension force of the quadriceps muscles of the operated leg was equal to that of the non-operated control legs. However, integrated electromyography revealed that vastus medialis activity was much reduced in the quadriceps muscles of the operated legs. This indicates that atrophy of vastus medialis can occur **without** impairment of knee extension; and confirms the finding of Santavirta (1979) that the other quadriceps muscles can compensate for the reduced vastus medialis function and produce normal extension power.

*Third*, electromyographic studies have clearly shown that rectus femoris, vastus intermedius, vastus lateralis and vastus medialis longus (see later) are all active during the full range of knee extension (Basmajian, 1974; Hallen and Lindahl, 1962; Lieb and Perry, 1971; Santavirta, 1979 and Wild *et al.*, 1982). Furthermore, electromyographic activity of all these muscles is maximal when the knee is almost fully extended (Wild *et al.*, 1982). This can in fact be deduced from consideration of the mechanics of knee extension. Because the knee experiences a great reduction in mechanical advantage during the last 15° of knee extension, it follows that the extensor muscles must exert a greater (60%) force in order to move the knee through this range. Therefore, failure to achieve full extension of the knee must be a reflection of weakness of the entire quadriceps muscle and not just the vastus medialis (Lieb and Perry, 1968 and Wild *et al.*, 1982).

*Fourth*, Lieb and Perry (1968 and 1971) found that the vastus medialis could be divided into two parts on the basis of the directional alignment of its fibres. The proximal fibres (vastus medialis longus), orientated at angles of 15° - 18° to the long axis of the femur, extend the knee. The distal fibres (vastus medialis oblique) which are covered with a very thin fascia, and produce the prominent bulge supero-medial to the patella, insert more obliquely at between 50° and 55°. They take no part in extending the knee, but align the patella during knee extension.

It is therefore clear that the visible wasting of the vastus medialis muscle is actually wasting of the visually prominent vastus medialis oblique portion, which does not participate in knee extension, nor does it externally rotate the tibia on the femur during the final 10° to 15° of knee extension. This rotation of the tibia, which helps to stabilise the knee when it is in full extension, is a result of ligamentous forces and articular alignment rather than muscular action (Lieb and Perry, 1971). The importance of this tibial movement was noted by Smillie (1949 and 1970) who proposed incorrectly that it was due to the action of vastus medialis which he therefore called "the key (muscle) to the knee". It is probably

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because of this incorrect interpretation that so much importance has been attached to vastus medialis.

Finally, there may be other causes of defective extension of the knee which have nothing to do with weakness of the vastus medialis muscle. Reflex inhibition of the quadriceps muscles caused by pain (Hallen and Lindahl, 1962; Wild *et al.*, 1982) and adhesion formation around the knee joint during periods of immobilization (Hallen and Lindahl, 1962) could contribute.

## CONCLUSION

Recent scientific studies prove that the vastus medialis muscle is not solely responsible for the final degrees of knee extension, but that all the quadriceps muscles play a part in this action.

Lower limb immobilization results in weakening of all the quadriceps muscles. During rehabilitation after such a period, it is therefore important to attain adequate strength of all the quadriceps muscles and not just vastus medialis. It would seem, however, that special attention should be paid to the vastus medialis oblique to ensure optimum patellar alignment during knee movement.

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Two thirds of the Member Organisations submitted data on membership of association; number registered, licenced or recognised; number practising; number in full/part-time practice; number graduated during 1980 and the ratio of physiotherapists per population. For South Africa figures were: 1185 members, 1550 registered, 965 in practice, 110 graduated in 1980 and the ratio is 1 physiotherapist to 15,350 population. The latter varied from 1 to ± 960 (Belgium) to 1 to 620 909 (India), with most Member Organisations having ratio of 1 to 3 000 to 6 000.

### NEWS FROM MEMBER ORGANISATIONS

#### Denmark

A full-time 10-month postgraduate course for teachers and clinical physiotherapists and occupational therapists was set up by the Ministry of the Interior in Arhus in September 1980. The course is integrated for teaching physiotherapy and occupational therapy and subjects cover: pedagogy (psychology, administration, environment and health); physiotherapy and occupational therapy (common and separate subjects); several optional subjects in classes, group sessions or individual papers.

#### Spain

The Spanish Association will host the 14th Congress of the European Confederation for Physical Therapy 17 - 21 June 1984 in Barcelona (see notice elsewhere).

#### Surinam

Introduction to neurodevelopmental treatment, a training course in Bobath principles was taught by Paul Helders and Gert Bouman of Holland, supported by a local orthopaedic surgeon, neurologist, paediatrician, psychology and speech therapist.